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Investigations of Solar Cell Parameters of Chemically Synthesized Cus/Cds Heterojunction

Research proposal submitted

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In the Subject

PHYSICS

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Introduction:

Solar energy is the important alternative to the conventional energy sources which have great potential to fulfill global energy demands. Solar cell or photovoltaic cell converts the light energy into electrical energy. Different photovoltaic materials are used to convert light energy into electrical energy by physical and chemical process. Each materials has a different physical and chemical properties and thus affects the performance of the device. Cost-effective, efficient and earth abundant solar absorber materials are inviting attention of the researchers. Semiconductor material with a suitable band gap and high absorption coefficient is an important for solar cell applications [1]. Heterojunction solar cell is formed by using different semiconductor material of distinct energy band gaps which includes wide band gap window layer & a narrow gap absorber layer on the substrate forming a junction, transparent conducting oxide to draw the current to outer circuit [2-3]. CuS is a p-type semiconductor material having band gap 1.81 eV and CdS is n-type material with band gap 2.2 eV and both of them act as absorber material [4-5]. The thin film technology plays an impotent role in the development of thin film transistor & photovoltaic. Deposition method has vital role in the device fabrication as it controls the properties of the thin film device. Deposition techniques are classified as physical vapour deposition and chemical deposition techniques [6-10]. Performance of heterojuntion solar cell is influence by compositions, crystal phase, surface morphology etc. [11]. Many researchers studied the solar cell with different chalcogenide absorber materials like CuInSe2 (CISe), Cu(In,Ga)Se2 (CIGS), CdTe etc and deposition techniques [12-13].

Literature Review:

F. I. Ezema et al. [14] Studied CdS/CuS & CuS/CdS heterojunction thin film deposited on the glass substrate using chemical bath technique at room temperature and measured absorption

coefficient, transmittance and band gap of individual and heterojunction thin films. the study reports that high absorbance is obtained in visible region and high transmittance is well in NIR region, which are the suitable for the photovoltaic devices.

M. Sam et al. [15] Synthesized Cu2S/CdS heterojunction with chemical bath deposition at the 60º C for a photovoltaic application. In this work first CdS thin film is deposited by CBD method on the substrate and over which Cu2S is deposited via an ion exchange and characterized using different analytical tools like EDS, XPS, XRD. Prepared thin films shows the band gap of 2.22eV which is important for the heterojunction silar cell applications.

V. S. Taur et al. [16] Studied the effect of annealing at 250º C on photovoltaic characteristics of Cu2S/CdS heterojunction thin film deposited by chemical ion exchange reaction method on FTO. Due to annealing band gap increases from 2.02 to 2.20 eV. The increase in efficiency reported from 0.09 to 0.24%.

M. Maleki et al. [17] Reported the synthesis of CuS-CdS/TiO2 heterojunctions using one pot hydrothermal technique extending an absorption of TiO2 in a visible region. They also synthesized CdS/TiO2 & CuS/ TiO2 to study effectiveness of CuS-CdS/TiO2 and found that heterojunctions of different semiconductors can improve the efficiency.

G. Y. Sheikh et al [18] Studied synthesis of CuS and CdS nanoparticles using chemical bath method forming heterogeneous nucleation and characterized for optical, structural, PEC, and electronic properties. The estimated optical band gap about 2.10 eV of CuS which ha s potential application in solar cells. The band positions of CuS and CdS are evaluated using cyclic voltammetry curves. *J*−*V* plots shows improved short-circuit current density of 0.71 mA cm−2 for the heterojunction compared to bare CuS showing 0.15 μA cm−2. The determined PCE of the heterojunction CuS/CdS is 0.65%.

A. S. Jadhav et al. [19] Prepared CdS–CuS heterojunction films on a copper substrate using a chemical bath deposition (CBD) method and characterized using different analytical techniques. The XRD pattern of CuS–CdS shows peaks corresponding to CuS (hexagonal) and CdS (cubic) structures. The optical absorption study shows absorption edge corresponding to CuS–CdS (band gap of 1.85 eV). Photo-electrochemical properties showed the highest conversion efficiency of 1.40% as against for potassium ferro–ferricyanide (0.38%) and polysulphide electrolytes (0.02%).

M. K. Dutta et al. [20] In this work CdS-Cu2S heterojunction thin film is deposited using chemical bath deposition technique on a non-conducting glass substrate. CdS layer was formed by depositing a chemical compound on the glass surface and Cu2S layer was grown by dipping a small portion of the CdS sample into a cuprous chloride solution. Forward and reverse bias I-V and C-V characteristics of the resultant n-CdS and p-Cu2S heterojunction diode were measured and analyzed for various doping concentrations. I-V characteristics showed that, as the doping concentration changes, the cut-in voltage of the heterojunction diode also changes due to a change in the barrier height.

Objectives:

Objective of this work is to prepare the thin film heterojunction solar cell forming a junction between absorber layer and buffer layer with optimized parameters of the materials used and evaluate the performance of the heterojunction solar cell.

Hypothesis:

a) Preparative parameters affect the performance of solar cell.

b) Thin film solar cell performance is dependent on deposition techniques.

Importance of the study:

When semiconductor is exposed to light, the different kinds of interaction between matter and incident light takes place that depends upon the energy band gap and nature of incident light. To achieve the maximum efficiency it is necessary to get absorb the large range of solar spectrum by the solar cell. Photons with the energy equal or greater than band gap are absorbed. Efficiency of solar cell depends on band gap also it influence the absorption property of the material. Therefore material and the preparative condition, deposition techniques plays crucial role in performance of the solar cell. Although some researchers used different deposition techniques to increase the efficiency of the thin film solar cell, still there is a scope for the study of CuS/CdS heterojuncton thin film by chemical deposition techniques. Therefore in this work we will study the CuS/CdS heterojunction for solar cell applications using optimized reparative parameters for better performance.

Methodology

Synthesis of heterojunction thin film

Quality of the thin film heterojunction solar cell depends on growth condition and deposition methods. To deposit the different layers of the selected materials chemical deposition method (chemical bath deposition, SILAR. Spray pyrolysis) will be employed. Conducting and non conducting substrate will be used to deposit the thin films.

Characterization:

a) Film thickness will be measured by weight and difference method.

a) X- ray Diffraction (XRD) characterization will give information about grain size, crystal structure, , lattice constants

b) Surface morphology will be studied using Scanning Electron Microscopy (SEM) characterization.

c) Energy Dispersive X-Ray (EDAX) : This will be performed to study elemental analysis.

d) Coefficient of absorption, transmittance, band gap will be calculated with the help of UV visible spectroscopy.

e) Electrical characterization: I-V Characterization, Short circuit current, open circuit voltage will be studied.

f) Other solar cell parameters such as fill factor, efficiency and related parameters will be studied.

Chapter Scheme:

Chapter 1 : Introduction

Chapter 2: Review of Literature

Chapter 3: Deposition and Characterization Methods

Chapter 4: Synthesis and characterization of CuS and CdS Thin films

Chapter 5: CuS/CdS heterojunction Solar cell

Chapter 6 : Results and Discussion

Year wise plan of work:

First Year:

- Survey on the previous work
- Synthesis of CuS and CdS thin films

Second year:

- Synthesis of Heterojunction soar cell
- Characterization of synthesized thin film heterojunction
- Publication in journal/ conferences

Third year:

- Analysis of data and calculation of the cell parameters

- Thesis writing

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